

Milestone 1 - Requirements Document

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Introduction

The GE Wayside Mobile Application is a tool that GE is developing to assist railroad local maintainers in troubleshooting the Wayside Controller systems. A Wayside Controller consists of the Switch Control, Crossing Control, and Signal Control which all provide different functions for the railway in order to guide the train. Some of these Wayside Controller systems can be found at railroad crossings, or in other words the intersection of a road and a railway.

As a part of the project, we are tasked with figuring out how to communicate with the ElectroLogIXS System. The ElectroLogIXS system is used to control many features of the railway. Specifically, we are interested in the recording and diagnostics part of the system. The system logs various vital and non-vital events, as well as changes to the system configuration and error messages.

Currently, when a local maintainer arrives at a Wayside Controller, he or she has to physically connect to the system to gain access to the ElectroLogIXS system. The local maintainer uses the ElectroLogIXS system to obtain the diagnostic log information. The maintainer will then take the raw log files and interpret each line item one by one based off of a physical guidebook that contains descriptions of common log items. These descriptions provide a human readable interpretation of the log entries, along with steps that need to be performed if the log entry is an issue that needs to be addressed.

If needed, the local maintainer must perform the diagnostic steps to try and solve an issue. This requires performing some action, then referring back to the logging system to check for a response. In some cases, the maintainer will travel a mile or more down the track to perform such a test. He or she must then physically travel back to the Wayside Controller to view the system's response.

The development of this mobile application will allow for the maintainer to download log entries in real time wirelessly from a mobile device. The maintainer will no longer need to physically connect to the Wayside Controller. During inclement weather or in below zero temperature situations, the maintainer can sit comfortably in a vehicle and review logging information without being forced to physically get out of the vehicle and connect to the system. If the maintainer needs to perform diagnostics, he or she will be able to view the logging information in real time wirelessly down the track without having to travel a long distance back and forth to the Wayside Controller.

Application for Android Mobile Device

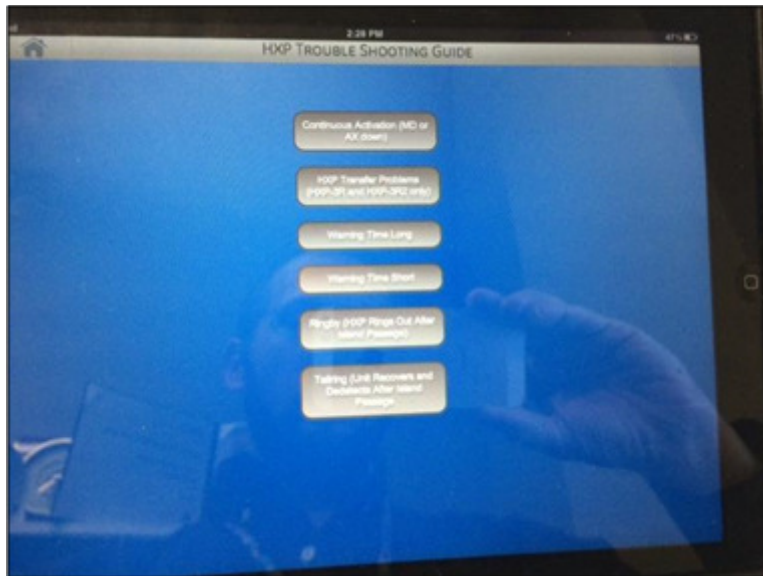
For the mobile application, we have proposed to develop the application on the Android platform. Our project is based on the Android operating system for several reasons. The Android operating system supports development in Java, which most of us are very comfortable with. Secondly, our proposed means of communication with the ElectroLogIXS system is WiFi Direct. As of right now, WiFi Direct is supported on Android devices, but not on iOS devices. Also, the Android SDK is free to download and experiment with and there are plugins for the Eclipse IDE, of which we are also familiar with. GE has also provided us with some existing source code for the Android platform.

Analysis of Existing GE Software

General Electric has provided us which documentation and source code of a previous attempt at this application which has code for both Android and iOS operating systems. Part of the requirements of this project is to analyze the existing software and run some source code complexity metrics such as the *McCabe Complexity Metric*, in order to determine if the source code is workable. If it is found that the code is not worth using, we will try and extract some existing communication protocols (if they exist) and start a new implementation of the project.

Screen shots of existing Mobile Application software:





Connect Wirelessly to ElectroLogIXS system

The main feature of the application will be the ability to obtain log information from the ElectroLogIXS system that is a part of the Wayside Controller. As of right now, the local maintainers must connect physically to the ElectroLogIXS via serial cable or ethernet cable. The goal of this project is to connect wirelessly to the ElectroLogIXS system to stop this inconvenience of physically connecting to the system. With this application, the local maintainer will be able to download log information in real time, connected wirelessly. This will eliminate the local maintainer's unnecessary requirement of walking back and forth to the box to obtain log information.

The main problem of communication with the ElectroLogIXS system is that some of these Wayside Controllers are in remote areas that do not have cell phone coverage. A solution to this problem is to use a local connection using WiFi Direct to connect wirelessly to the system. A WiFi module will be installed into the ElectroLogIXS system, which will allow for the communication.

WiFi Direct is essentially peer to peer connection that requires both devices to have WiFi capabilities. Using this method, a connection is established that does not require a router, bluetooth, or cellular network connectivity. This is very useful for devices trying to share data.

WifiP2PManager required class:

Initialize(), connect(), cancelConnect(), requestConnectInfo(), createGroup(), removeGroup(), requestGroupInfo(), discoverPeers(), requestPeers()

In order to create a connection, there are several steps needed in the application.

1. Create a broadcast receiver for intents
2. Discover peers
3. Connect to peers
4. Transfer data

Listeners and intents are required in order to make use of the Wi-Fi P2P connection. Once the data is transferred from the ElectroLogIXS System, it will be compared to what was already previously downloaded as to not have redundant data.

One of the end goals for this project, however, is that the local maintainer must be able to connect remotely to the system up to a mile away. Currently, WiFi Direct has a range of only an eighth of a mile. WiFi Direct is the proposed means of communication for the prototype and further research and development must be performed in order to implement wireless communications to fulfill the requirements for up to a mile away. However, this is not in the scope of this project and GE has agreed that short range communication is acceptable for our project.

Download ElectroLogIXS log events

Currently, the only way to connect to the ElectroLogIXS at the moment is physically through serial cable or ethernet. The ElectroLogIXS system has an embedded web server, which provides information about the status of the system, setup information, diagnostic and logs. In order to retrieve the logs, the local maintainer must navigate to the web page and read the log items.

Our application will retrieve this information wirelessly through WiFi Direct. At the moment we are unsure if we have FTP access to the system. If an FTP session can be established, it may be possible to download the log files directly.

Our temporary solution for retrieving the log files is to have the application download the log files displayed on the html web page by screen scraping. Our application will parse the data and store it into a CSV file or database locally on the Android device. The application will display the log information in a much more organized manner for the local maintainer to read. When the cellular device is within range of a cellular network, it will then upload the data to a server, which will then store the data into a database.

ElectroLogIXS Troubleshooting Guidebook

The troubleshooting guidebook contains information about the format of each log file that will be stored in the ElectroLogIXS system on the Wayside Controller. In the troubleshooting guide,

there is a descriptive, human readable definition of each log entry along with steps of actions for the local maintainer to perform in order to troubleshoot the system. The Android application will download the logs from the ElectroLogIXS system in each Wayside Controller, reference the troubleshooting guidebook and then output readable descriptions and actions for the local maintainers to perform.

Currently, each local maintainer has a physical copy of this troubleshooting guide that contains about 75% of the log entries. A digital copy of the guidebook is available to us in the form of an excel spreadsheet from GE. It is required that the document needs to be parsed and stored into a CSV file or database in an organized manner in order to be referenced by our Android application.

As mentioned above, the guidebook contains information for about 75% of the log entries. One of the end goals of this project is to have the application report undocumented log entries in hopes of having a more complete documented list of all logs. We will accomplish this by storing unknown log entries and evaluating them. Once one of these unknown log entries is identified and accurately described, it will be added to the troubleshooting guidebook.

Example of a ElectroLogIXS Troubleshooting Guidebook Entry:

error_id	error_text	description	actions	module
0	SLOT # VTI Track # Open Track Circuit Detected	The minimum amount of transmit current was not measured while the VTI transmit switch was enabled.	1) Check the integrity of the track connections. 2) Check for broken rail or joint bonds. 3) Check the integrity of the VTI module fuses. 4) Reboot one end of the ElectroCode track circuit. 5) Replace the VTI module.	VTI

The maintainer will click on a specific log that has to do with the current issue at the wayside control box, which will then give a description of what the record means and the steps the local maintainer will attempt in order to resolve the issue.

Storage of ElectroLogIXS log events

The application will store temporary data on the phone in the form of either a CSV file or database in order for the local maintainer to complete the tasks required to fix the error. The application will also compare previous data obtained to reduce the amount of log files that need to be downloaded in order to not overload the CPU of the ElectroLogIXS system. After the

local maintainer has finished his field work and is in range of a cellular or wireless network that is connected to the dispatch network, the data downloaded from that wayside controller box will be uploaded to a central database located at General Electric for statistical purposes.

Log Search Feature

The log search feature will give the user the ability to look for specific instances in the logs. The search features will include data such as: specific dates/times of occurrences, type of log event, particular system component failure, and condition of track. This search feature will be easy to use and based on many of the popular advanced search engines tailored to be specific for our application and it's functionality. The user will input into any one of the fields and get the matching record back from the database located on the phone storing all of the logs that were just downloaded by the technician to diagnose the wayside control box.

Search Records Keeping

The application will keep records of the different searches performed by the local maintainer in order to gain statistical data for use by General Electric. Hardware malfunctions will be detectable based on the accumulated data into the General Electric database of the logs that the local maintainers have obtained over a period of time. This data will provide the company with information to improve their ElectroLogIXS hardware and systems in order to reduce future maintenance in replaced wayside controller parts. This data will also be used to improve efficiency of the local maintainers use of time when it relates to certain log entries and how to deal with them quickly. Also, due to environmental conditions, statistical patterns may be visible in certain areas that may require particular attention. Sample input would be common searches that the technician had to perform on a specific box multiple times due to a flaw in the design of the wayside controller.

Graphic User Interface Layout

The GUI of the application will be an easy to navigate design for the local maintainers. The following screenshots are rough designs of the GUI used to layout the basic functions of the application

On load of the application the maintainer will be prompted to type in a user name and login. The only way to access any of the features of the application would be on a successful login.

General Electric Wayside Troubleshooting Tool

USER:

PASSWORD:

LOGIN

After a successful login, the maintainer will be shown a main screen with a set buttons to click.

General Electric Wayside Troubleshooting Tool

● Connected to: N/A

CONNECT

SEARCH

HISTORY

CONTACT HOME

HELP

Connect: This button will bring up another screen that has a list of the various systems that the application is able to connect to in range. After a successful connection, a status of connection on all of the other screens will be shown for the connected system. Green means connection is good and a red means not connected. If at any point, a connection is lost, a popup screen shall appear notifying the maintainer of the lost connection.

General Electric Wayside Troubleshooting Tool

Connect to:

Controller #	Location	Status
10001	Main St/North St	Good
10002	Main St/North St	Good
10003	Main St/North St	Good
10004	Main St/North St	Good
10005	Main St/North St	Good
10006	Main St/North St	Good

Search: This button will bring up a search screen. The search screen will provide a way for the maintainer to search through the log files effectively. More information on this search feature can be found in the section titled, “**Log Search Feature**.” If a connection is lost, the maintainer will only have the ability to search through log files cached on the mobile device.

General Electric Wayside Troubleshooting Tool

● Connected to: Wayside #10001

Search:

Error:

Date:

Module:

Search

History/Search Results: After a maintainer performs a search, the following screen of Search Results will appear. This screen is identical to the History screen that is shown after clicking on the History button on the main screen. The only difference is, the History button will show all of the recent history, whereas the Search Results will be a filtered list of the history based on the maintainer's search. The user will also be able to click on any of the column headers to sort by each column. Notice in the following screen shot, a connection is established. Should a connection be lost, the results shown will be results from the log files cached on the device.

[illegible]

Individual Error Log: From the History/Search Results screen, the maintainer will have the option to select an individual log file to bring up a more detailed screen of the log selected. In this window, the maintainer will be given a human readable description of the error along with actions to perform if steps are needed.

General Electric Wayside Troubleshooting Tool	
● Connected to: Wayside #10001	
Error:	Description:
.....
Actions:	
1.	<input checked="" type="checkbox"/>
2.	<input type="checkbox"/>
3.	<input type="checkbox"/>
4.	<input type="checkbox"/>
5.	<input type="checkbox"/>